



## Double Trouble: Post COVID Pulmonary Sequelae

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### Abstract

**Background:** Coronavirus disease 2019 (COVID-19) is an infectious acute respiratory disease caused by a novel coronavirus. The World Health Organization (WHO) was informed of cases of pneumonia of unknown microbial aetiology associated with Wuhan City, Hubei Province, China on 31 December 2019<sup>1,2</sup>. The first case was reported in India on 27<sup>th</sup> January 2020 and in Srikakulam on 25<sup>th</sup> April 2020. As per WHO, patients will recover with an incubation period of 10 to 14 days, sometimes COVID symptoms can remain for more than 20 days up to 45 days due to the long-term effect of COVID and patients develop Post COVID complications. Multi-organ involvement seen in patients who had a severe illness, lung being most commonly involved. Other organs involved are the heart, brain, vascular system, kidney, skin<sup>4</sup>. Here, we provide a comprehensive review on complications of the respiratory system arising in post-COVID patients depicted as post-COVID pulmonary sequelae

**Aim of the Study:** To evaluate the post COVID pulmonary complications, treat the cause and prevent disease progression

**Materials & Methods:** This is a prospective observational study conducted on 77 patients recovered from COVID-19 for a duration of 6 months, in Great eastern medical school & hospital, Srikakulam, Andhra Pradesh which was a District COVID hospital. The study was done in COVID patients after recovery, within a duration of 1 month to 6 months with a confirmed diagnosis of COVID-19 in the second wave in the year 2021. A register would be made for data collection for both out-patients and in-patients. Information will be collected regarding symptoms, history, personal history. HRCT chest, sputum bacterial culture, TRUENAAT is done to assess complications and prevent them. The study was conducted after obtaining consent from patients.

**Results:** Among 77 study populations, the analysis showed males were 71.43% and females were 28.57% with an age group of 41-60 years is most commonly involved. Most of the patients presented with a duration of symptoms >1 month i.e., 29.87%. Most common complication encountered was pulmonary fibrosis 23.37%, Fungal pneumonia 10.3%, Allergic rhinitis 10.3%, death 10.38%, pleural diseases 9%, diabetes 9%, pulmonary TB 6.49%, Extrapulmonary (pleural) TB- 5.19%, Extrapulmonary complications 2.59%.

**Conclusion:** The pulmonary sequelae of COVID-19 after the acute phase of COVID-19 is increasingly being appreciated. COVID-19 affects people of all age groups and gender. It neither spares people with comorbidities nor those without any comorbidities. Social distancing, proper mask and hand hygiene will be the long-lasting self-disciplinary measures to curtail the spread of the disease.

**Keywords:** Post COVID complications, COVID-19, Pulmonary sequelae

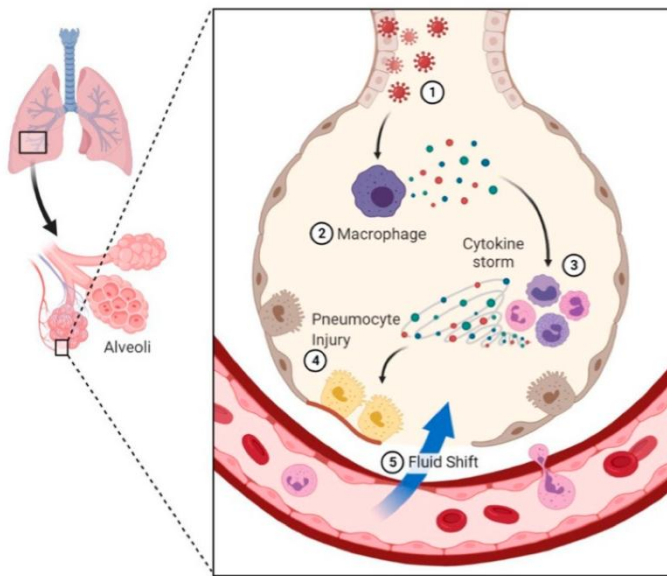
**Introduction**

Coronavirus disease 2019 (COVID-19) is an infectious acute respiratory disease caused by a novel coronavirus. The World Health Organization (WHO) was informed of cases of pneumonia of unknown microbial aetiology associated with Wuhan City, Hubei Province, China on 31 December 2019. The WHO later announced that a novel coronavirus had been detected in samples taken from these patients. Since then, the epidemic has escalated and rapidly spread around the world, with the WHO first declaring a public health emergency of international concern on 30 January 2020, and then formally declaring it a pandemic on 11 March 2020. Clinical trials and investigations to learn more about the virus, its origin, how it affects humans, and its management are ongoing<sup>3</sup>

**Definition**

A potentially severe acute respiratory infection caused by the novel coronavirus severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2)<sup>5</sup>. The clinical presentation is generally that of a respiratory infection with a symptom severity ranging from a mild common cold-like illness, to a severe viral pneumonia leading to acute respiratory distress syndrome that is potentially fatal. Characteristic symptoms include fever, dry cough, dyspnoea, and loss of taste/smell, although some patients may have mild upper respiratory tract symptoms or be asymptomatic. Complications of severe disease include, multi-organ failure, septic shock, and venous thromboembolism. Symptoms may be persistent and continue for more than 12 weeks in some patients<sup>6</sup>.

**Pathogenesis**



**Pathophysiology of COVID-19**

- ① **Viral Entry**  
*ACE-2 & TMPRSS-2 Receptors*
- ② **Macrophage Activation**  
*CD-8+ T cells, Neutrophils, Lymphocytes*
- ③ **Pro-inflammatory Cascade**  
*IL-6, IL-10, IL-2, IL-1β, TNF-α, IFN-γ, VEGF, ROS, Proteases*
- ④ **Acute Lung Injury**  
*Alveolar oedema, Tachycardia, Tachypnoea, Hypotension*
- ⑤ **Respiratory Failure**  
*Acute Respiratory Distress Syndrome, Systemic Inflammatory Response Syndrome, Multi-Organ Dysfunction Syndrome*

**Fig 1:** pathogenesis of COVID-19

**Post COVID**

The mechanism of post-COVID conditions is not well understood, but is hypothesized to be secondary to virus-specific pathophysiologic changes, prolonged inflammatory response to the acute infection and sequelae of post-intensive care illness

Post-COVID conditions are referred to by a wide range of names, including “long COVID,” “post-

COVID syndrome,” “post-acute COVID-19 syndrome,” as well as the research term “post-acute sequelae of SARS-CoV-2 infection” (PASC). Among the lay public, the phrase “long-haulers” is also used.<sup>7,9</sup>

Long COVID is used to describe signs and symptoms that last for longer than 4 weeks after getting COVID-19<sup>8</sup>

There are two stages to what is commonly known as Long COVID<sup>5</sup>:

- Ongoing symptomatic COVID-19 – symptoms that last 4-12 weeks
- Post-COVID-19 syndrome – symptoms that last for more than 12 weeks and can't be explained by another diagnosis

## Materials & Methods

### Objective of the Study

1. To study the clinical picture
2. To study the radiological pattern
3. To analyse the microbiological flora

### Aim of the Study

To identify the post COVID complications, treat the cause and to prevent disease progression

**Study Group:** post COVID patients

**Study Design:** prospective observational study

**Place Of Study:** patients attending out-patient and In-patient of GEMS Hospital, Sriakulam.

**Duration of Study:** 6months

**Study Sample:** 77

**Methodology:** patients attending GEMS Hospital, sriakulam with cough, dyspnoea, fever, general malaise, cold with past history of COVID in 2<sup>nd</sup> wave and follow-up patients is included in our study.

The study was done in COVID patients after recovery within a duration of 1month to 6months A register would be made for data collection for both out-patients and in-patients.

## Results

**Table 1:** Age wise Distribution

Age group	No. of patients	%
18-20	3	3.90%
21-30	6	7.79%
31-40	13	16.88%
41-50	21	27.27%
51-60	20	25.97%
61-70	9	11.69%
71-80	3	3.90%
>80	2	2.60%
Total	77	100%

The minimum age taken in the study was 18 and maximum age 85. Most common age group affected was between 41-60 years (53.34%).

Information collected regarding symptoms, past history, personal history. HRCT chest, sputum bacterial culture, sputum TRUENAAT is done to assess complications and prevent it.

### Inclusion Criteria

1. All patients who suffered from COVID recovered, discharged and tested negative for COVID with documented evidence.
2. Age >18years
3. Patients with comorbidities: Diabetes, Hypertension, Pulmonary TB, Bronchial asthma etc.,
4. Smokers & non-smokers

### Exclusion Criteria

1. Age <18years
2. Active COVID infection.

The nature and purpose of the study was explained in detail to all the study Patients and written informed consent was obtained from all of them included in this study. Data collection was done as per the proforma

### Study Procedure

Patients re-admitted with symptoms after recovery from COVID-19 from 1month to 6months duration were studied. Clinical presentation, comorbidities, personal history with CT CHEST, sputum bacterial and fungal culture, sputum TRUNAAT was done to analyse the complications and treat at the earliest. Patients admitted with post COVID were evaluated for study after inclusion and exclusion criteria analysis.

**Table 2:** Sex Distribution

Sex	No. of patients	%
Male	55	71.43%
Female	22	28.57%
Total	77	100%

Males are more commonly affected than females.

**Table 3:** Age wise sex distribution

SEX	N	Mean age in years	Std. Deviation	Student independent t-test
Male	55	48.69	14.56	t=0.13 p=0.90 (not-Significant)
Female	22	49.18	15.36	

Males mean age is 48.69 years and females mean age is 49.18 years. Overall mean age is 48.83 years and SD is 14.70 years

**Table 4:** Chief Complaints of Study Patients

Chief complications	No. of patients	%
Asymptomatic	6	7.79%
Chest pain	10	12.99%
Cold	8	10.39%
Dry cough	17	22.08%
Dyspnoea	12	15.58%
Fever	17	22.08%
General malaise	2	2.60%
Headache	1	1.30%
Jerking of limbs	1	1.30%
Productive cough	3	3.90%
Total	77	100%

Majority of patients presented with dry cough 22.08% and fever 22.08%

**Table 5:** Duration of symptoms

Duration	No. of patients	%
Nil	6	7.79%
< 7 days	16	20.78%
8-15 days	12	15.58%
1 month	20	25.97%
>1 month	23	29.87%
Total	77	100%

Majority of patients i.e., 55.84% having symptoms >1 month  
Duration couldn't be assessed in 7.79% patients

**Table 9:** Comorbidities

Comorbidities	No. of patients	%
Diabetes	12	15.58%
Bronchial asthma	2	2.59%
Hypertension	1	1.30
No comorbidities	61	79.22%
Pulmonary TB	1	1.29%
Total	77	100%

**Table 10:** Smoking Status

Smoking status	No. of patients	%
Non smoker	42	54.55%
Smoker	35	45.55%
Total	77	100%

**Table 11: Immunisation Status for COVID**

Vaccination status	No. of patients	%
Not Vaccinated	61	79.22%
Vaccinated	16	20.78%
Total	77	100%

**Table 12: HRCT Chest**

HRCT FINDINGS	No.of cases	%
Aspergilloma	1	1.3
Cavity with consolidation	1	1.3
Cavity with aspergilloma	2	2.6
Cavity with bronchiectasis	1	1.3
Consolidation	4	5.2
Destroyed lung	1	1.3
Empyema	1	1.3
Hydropneumothorax	2	2.6
Normal	28	36.4
Pleural effusion	2	2.6
Pneumomediastinum	1	1.3
Pneumothorax	7	9.0
Pulmonary fibrosis	21	27.3
Pulmonary fibrosis with traction bronchiectasis	1	1.3
Pulmonary fibrosis with infiltrates	1	1.3
Pulmonary fibrosis with left pleural effusion	1	1.3
Subcutaneous emphysema	1	1.3
Subcutaneous emphysema with pneumomediastinum	1	1.3
Total	77	100%

**Table 13: Side of involvement**

SIDE OF INVOLVEMENT	No. of cases	%
Nil	28	36.36
Bilateral	26	33.7
Left	12	13.0
Right	11	14.28
Total	77	100%

28 patients had normal CT chest with no significant findings, side of involvement is mentioned as nil in 36.36% study population

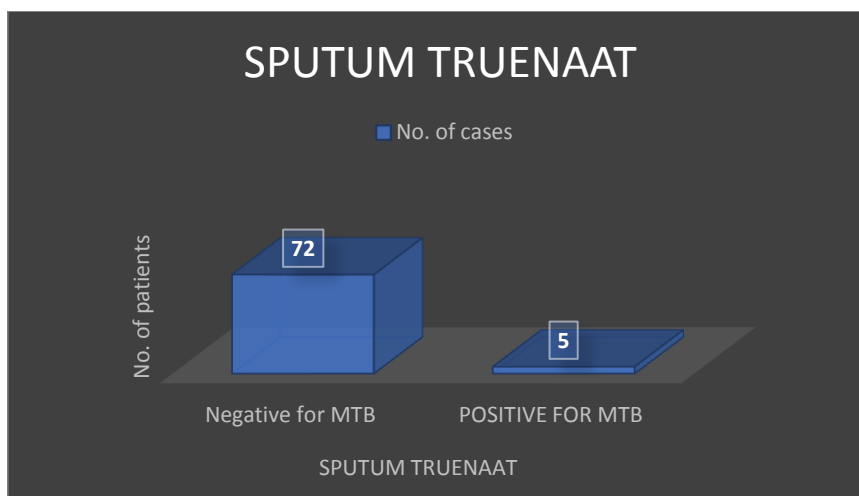
**Table 14: Sputum Culture**

Culture	No. of cases	%
<i>Aspergillus</i>	7	9.09%
<i>Candida</i>	2	2.60%
<i>E.coli</i>	1	1.30%
<i>Klebsiella</i>	1	1.30%
<i>H.influenza</i>	8	10.39%
No growth	55	71.42%
<i>Pseudomonas</i>	1	1.30%
<i>Streptococcus</i>	2	2.60%
Total	77	100%

Normal oropharyngeal growth is observed in majority of patients 71.42%, *H.influenza* 10.39%, *Aspergillus* 9.09%, *Candida* 2.60%.

**Table 15:** Sputum Truenaat for Mycobacterium tuberculosis

Sputum TRUENAAT	No. of cases	%
Negative for MTB	72	93.50%
POSITIVE	5	6.49%
TOTAL	77	100%



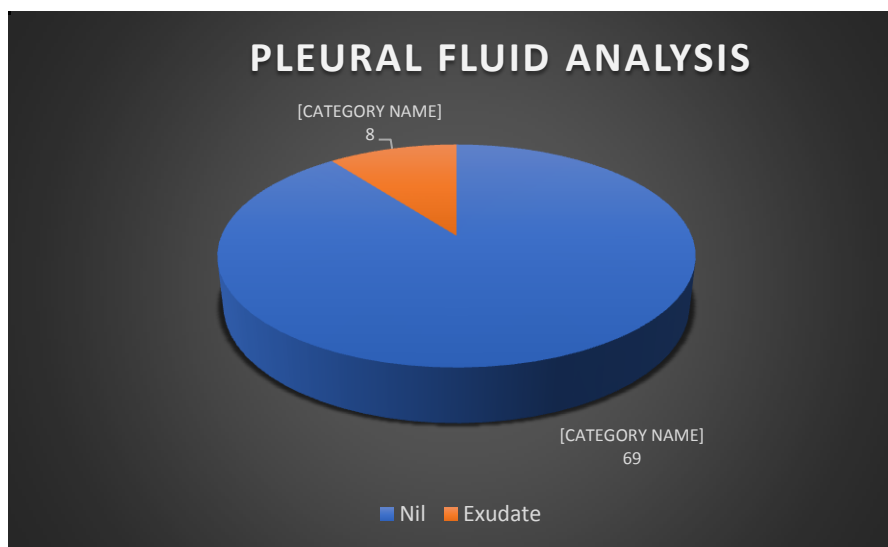
**Fig 2:** Shows sputum TRUENAAT to detect Mycobacterium tuberculosis in post COVID patients

**Table 16:** Pleural Fluid Analysis

PLEURAL FLUID	No. of cases	%
Nil	69	89.61%
Exudate	8	10.3%
TOTAL	77	100%

Out of 77 study population Pleural effusion is seen in only 8 patients.

Exudative type of pleural effusion is seen in all the 8 patients with raised ADA levels.



**Fig 3:** Showing exudative type of pleural effusion in 8 patients

**Table 17: Complications**

S.no	complications	No. of cases	%
1.	Allergic rhinitis	08	10.3%
2.	Aspergilloma +Pulmonary TB -01	03	3.8%
3.	Fungal pneumonia +aspergillus -06 +candida - 02	08	10.3%
4.	Diabetes +empyema-01 +aspergillus- 01	07	9%
5.	Hydro-pneumothorax +empyema -01 +TB pleural effusion-01	02	2.59%
6.	Myocardial infarction	01	1.29%
7.	Generalised tonic clonic seizures	01	1.29%
8.	Pulmonary fibrosis	17	23.37%
9.	Pneumothorax +empyema -02 +BPF -02 +necrotizing pneumonia -01	06	7.79%
10.	Sub-cutaneous emphysema +pneumomediastinum -02 +pulmonary fibrosis -01	04	5.19%
11.	Pulmonary TB +bronchiectasis -01 +(diabetes+fibrosis)-01	04	5.19%
12.	Tubercular pleural effusion	03	3.38%
13.	No complication	13	16.8%

**Table 18: Mortality rate**

MORTALITY	No. of cases	%
Survived	69	89.61% %
Death	8	10.38%
Total	77	100%

**Table 19: Association between Outcome and age in post COVID patients**

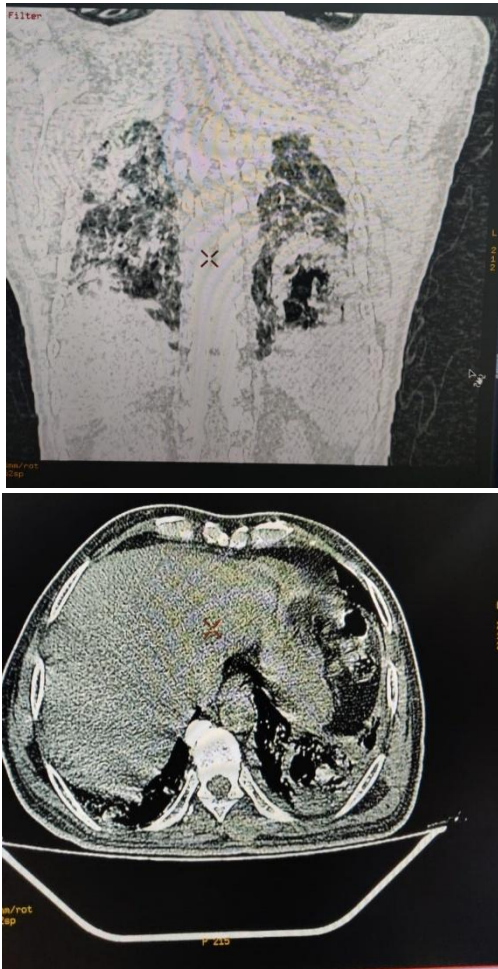
	Outcome				Yates corrected Chi-square test
	Discharged		Death		
	n	%	n	%	
< 40 years	22	100.00%	0	0.00%	$\chi^2=2.18$ p=0.14 (NS)
>40 years	47	85.45%	8	14.55%	

Statistical analysis was done using Chi-square test obtained P-Value of 0.14(Non-significant). Death observed in patients with age above 40years, survival rate is seen in patients with age <40 years.

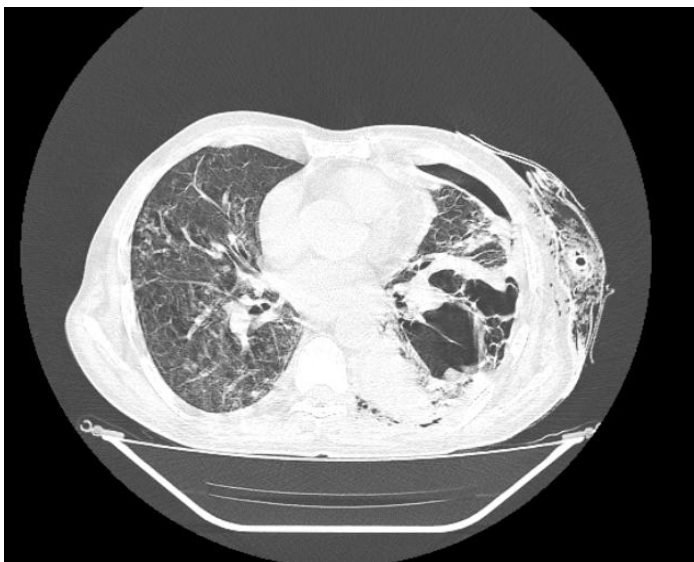
**Table 20: Association between Outcome and sex in post COVID patients**

	Outcome				Yates corrected Chi-square test
	Discharged		Death		
	n	%	n	%	
Male	48	87.27%	7	12.73%	$\chi^2=0.42$ p=0.52(NS)
Female	21	95.45%	1	4.55%	

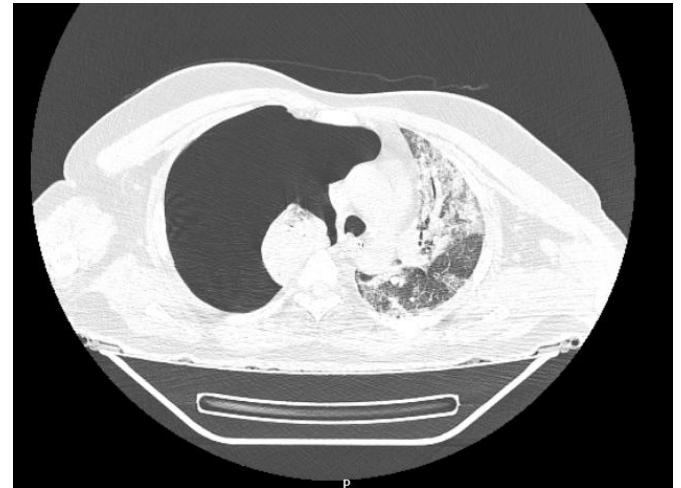
Among 48 males death observed in 7 patients, out of 21 females death occurred in 1 case



**Fig 4:** CT chest showing a. coronal section with a cavity in left lower zone with a fungal ball b. axial section (mediastinal window) showing left lower lobe cavity with fungal ball



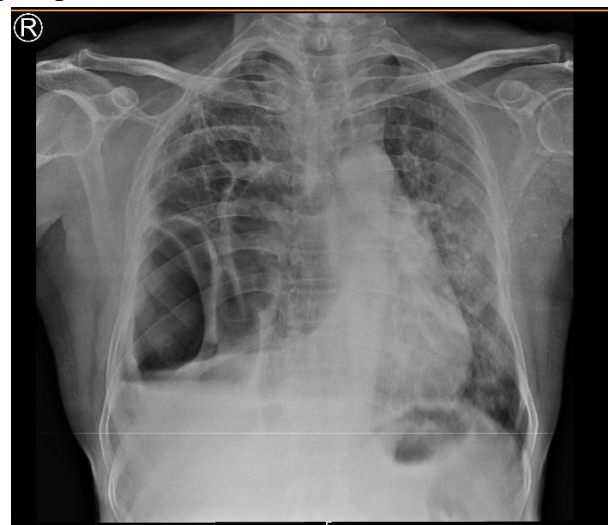
**Fig 5:** CT chest axial view showing left necrotising lung with pneumothorax



**Fig 6:** CT chest axial view showing right side pneumothorax with ground glass opacification in left lung



**Fig 7:** CT chest axial view showing left side hydropneumothorax



**Fig 8:** Chest x-ray showing right loculated hydropneumothorax



## Discussion

1. Clustering of cases seen between age group of 41 to 60 years, least number of cases seen in extreme age groups.
2. Males were more commonly affected than females
3. Majority of the follow up cases presented with persistent dry cough 22.08%, fever 22.08% and 15.58% presented with dyspnoea.
4. 29.87% patients presented with duration of symptoms more than 1month, 25.97% with duration of 1month.
5. Most of the patients had no comorbidities, 15.58% presented with past history of diabetes mellitus, 2.59% with bronchial asthma, 1.29% with systemic hypertension, 1.29% with pulmonary tuberculosis.
6. None of the patients were vaccinated before contracting disease, 20.78% patients received only 1<sup>st</sup> dose of COVID vaccination after recovery.
7. 45.55% were smokers, 54.55% were non smokers
8. Most of the patients presented with pulmonary fibrosis on CT chest i.e., 24 among 77 patients has pulmonary fibrosis with other findings like traction bronchiectasis, infiltrates, pleural effusion. 36.4% patients had normal CT chest which include stable, follow-up patients. Subcutaneous emphysema is seen in 1.3%, subcutaneous emphysema with pneumomediastinum in 1.3%, cavity with consolidation seen in 1.3%, consolidation 5.2%, empyema 1.3%, hydropneumothorax 2.6%, pleural effusion 2.6%, pneumomediastinum 1.3%, pneumothorax 9%, aspergilloma 3.9%.
9. Bilateral lung involvement is most common in 33.7%, left lung 13%, right lung 11%.
10. Sputum analysis was done in admitted patients and stable OP patients, Sputum

culture shows normal oropharyngeal flora in 71.72%, *H.influenza* 10.39%, *Aspergillus* 9.09%, *Candida* 2.60%, *Streptococcus* 2.60%, *E.coli* 1.3%, *Klebsiella* 1.3%, *Pseudomonas* 1.3%.

11. Sputum for TRUENAAT is done to rule out pulmonary tuberculosis out of 77 study patients 5 patients detected positive for TRUENAAT i.e., 6.49%.
12. Most common complication encountered was pulmonary fibrosis 23.37%, Fungal pneumonia 10.3%, Allergic rhinitis 10.3%, death 10.38%, pleural diseases 9%, diabetes 9%, pulmonary TB 6.49%, Extra pulmonary(pleural) TB- 5.19%, Extra pulmonary complications 2.59%.
13. Allergic rhinitis was seen in 10.3% of post COVID patients who never had an history of allergy in the past.<sup>10</sup>
14. Pleural fluid analysis shows exudative type among 8 (10.3%) patients in 77 study population.<sup>11</sup>
15. Death occurred in 10.38% which include patients of necrotising pneumonia, massive pneumothorax, pneumomediastinum, empyema.
16. Fungal pneumonia is seen in patients with history of diabetes. 9% of patients had denovo diabetes in post COVID condition with no past history of diabetes mellitus.
17. A diabetic Patient with haemoptysis had Aspergilloma with persistently elevated Absolute eosinophil count and serum IgE levels.
18. Death rate was seen in 10.38% out of 77 study population.

## Conclusion

Post COVID patients with continuous fever, shortness of breath, dry cough, productive cough, haemoptysis should be evaluated to rule out post COVID complications. The pulmonary sequelae of COVID-19 after the acute phase of COVID-19 is increasingly being appreciated. COVID-19 affects people of all age groups and gender. It

neither spares people with comorbidities nor those without any comorbidities. Social distancing, proper mask and hand hygiene will be long lasting self-disciplinary measure to curtail the spread of the disease.

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